Kaons 41 papers (+20 rev./th.) and 113 measurements

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- K^+, V_{us} and semileptonic kaon decays, cusp effect in $K \to 3\pi$
- K^0 and CPT tests
- K_S
- K_L

$K \to \pi l \nu$ and CKM unitarity

$$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$$ V_{ub} negligible

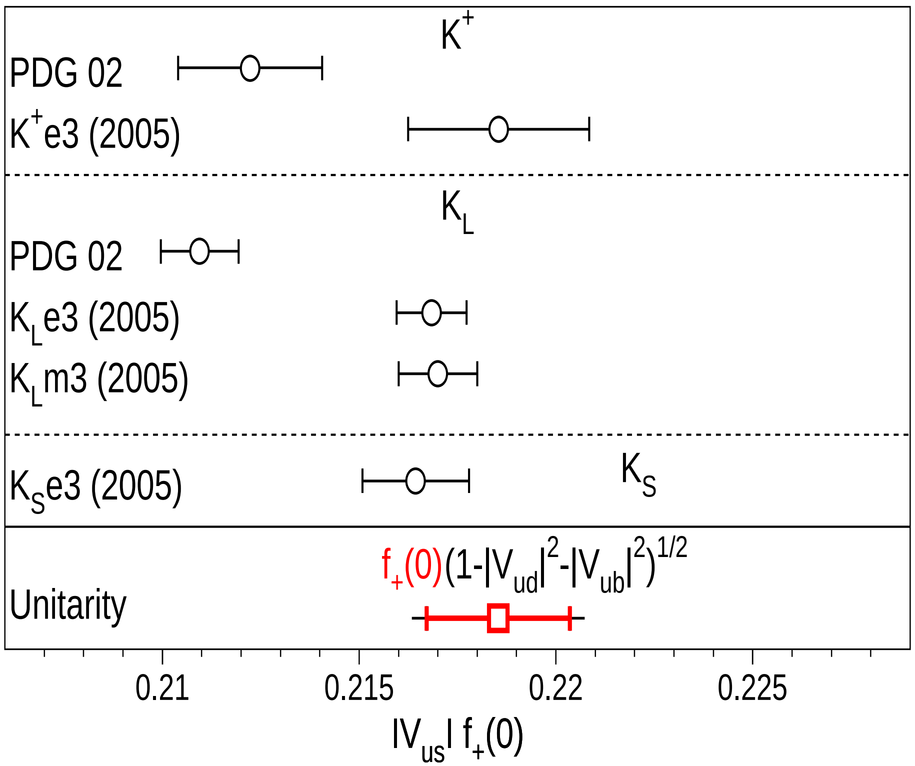
- Superallowed transitions $\Longrightarrow |V_{ud}| = 0.9738 \pm 0.0003 \stackrel{\text{Unit.}}{\Longrightarrow}$

$$|V_{us}|^{\text{Unit.}} = \quad 0.2275 \pm 0.0012$$

$$|V_{us}|^{\text{PDG04}} = 0.2196 \pm 0.0026$$ Leutwyler,Roos

$$|V_{us}|^{\text{PDG06}} = 0.2257 \pm 0.0021$$ All K's

V_{us} and V_{ud}: PDG02/PDG04 vs. PDG06



New Review on V_{us} and V_{ud} by Blucher and Marciano

$$\Gamma(K_{l3}^{i}) = \mathcal{N}_i |V_{us}|^2 |f_+(0)|^2 (1 + \delta_{rad}^{l}) I(\lambda_+, \lambda_0)$$

- $\Gamma(K_{l3}^{i})$ improvements in: K_{e3}^{+} (BNL,NA48), $K_{e3}^{0}, K_{\mu 3}^{0}$ (KTeV, NA48, KLOE)

- Form factor $f_{+,0}(t) = f_+(0)(1 + \lambda_{+,0} t/m_\pi^2)$

  Now measured more accurately. KTeV,KLOE and ISTRA+ (contrary to NA48) measure non-zero quadr. slope in $f_+(t)$. PDG fits have been redone

  $I(\lambda_+, \lambda_0)$ phase space integral improved by new measurements

- TH radiat./isospin breaking corr. δ_{rad}^{l} known accurately BUT all expts. must include the same corr.

- $SU(3)_I$-breaking $\longrightarrow$ $f_+(0) = 0.961 \pm 0.008$ Leutwyler Roos,Chiral,Lattice

K^+: V_{us} related measurements

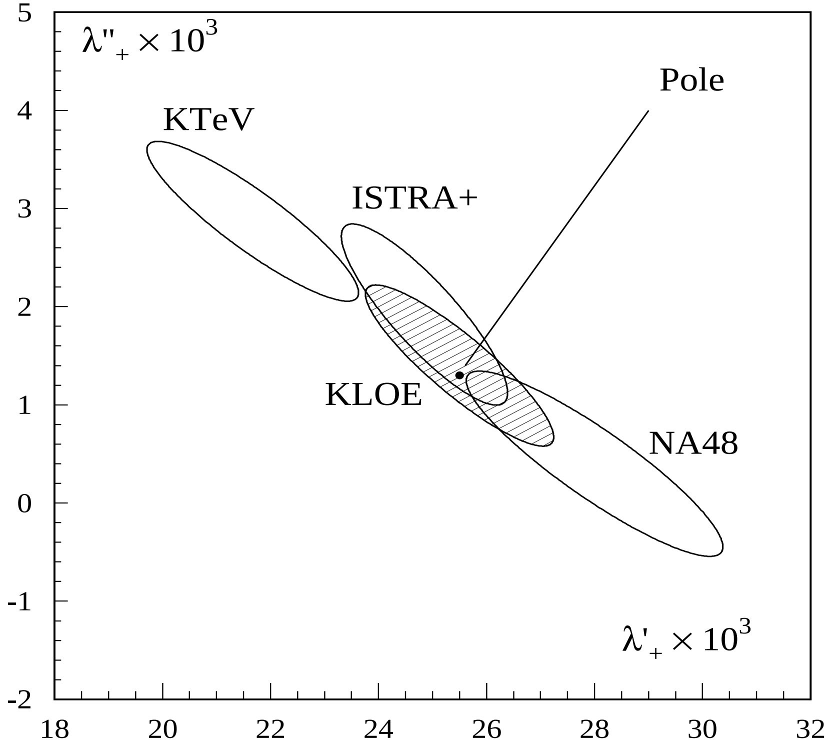
- $B(K^+ \to \pi^0 e^+ \nu)$ by Sher et al. (BNL 865) NOT included in PDG 04, included in 06

- $B(K^+ \to \mu^+ \nu)$ by KLOE (included)

- Istra Data with quadratic parametrization included (in PDG04 we just took the linear parametrization and added in footnotes the quadr. ones)

- Tom has updated the $K_{\ell 3}$ form factor review to include linear, quadratic and polar parametrization

Quadratic - linear slopes plot: pole/quadr. parametriz.



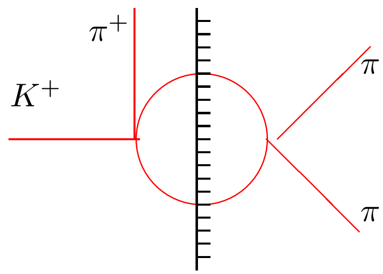
Quadratic expansion has large correlations and various expts. are disagreeing; the pole is more stable.

KLOE

a_0, a_2 from $K \to 3\pi$ rescattering; Cabibbo,Cabibbo-Isidori

- rescattering generates an absorptive contribution proportional to the scattering lenghts a_0, a_2

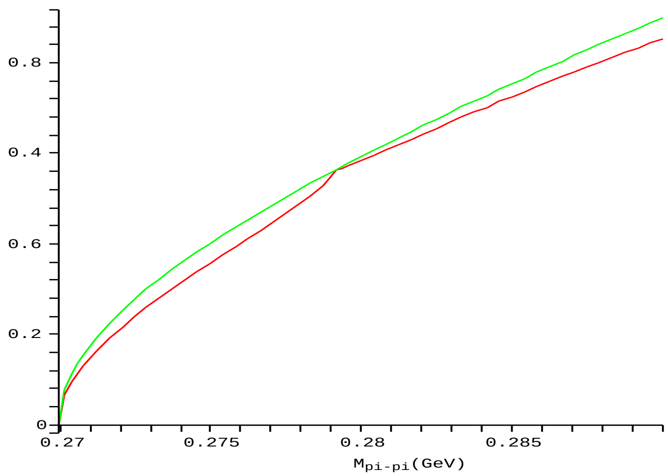
Final State Interaction



Zeldovich,Grinstein et al
Isidori,Maiani,Pugliese

The amplitude T(s) has a critical behaviour near $\pi\pi$ threshold: NA48 good energy resolution$\Longrightarrow a_0, a_2$

a_0, a_2 Cabibbo,Cabibbo-Isidori



- No cusp with cusp
- cusp: opening of the $\pi^+\pi^-$-threshol
- Rescattering $\pi^+\pi^- \longrightarrow \pi$ proportional to $a_0 - a_2 \Longrightarrow$

$$\left.\frac{d\Gamma(K^+ \to \pi^+\pi^0\pi^0)}{dM_{\pi^0\pi^0}}\right|_{\mathrm{NA48}} \Rightarrow \mathrm{cusp\ for} M_{\pi^0\pi^0} = M_{\pi^+\pi^-}$$

$$\stackrel{\mathrm{cusp}}{\Rightarrow} a_0 - a_2.$$

$$K^+ \longrightarrow \pi^+\pi^0\pi^0$$

- TNF and Istra NO CUSP effect Linear and Quadratic slope measured.

- CUSP effect NA48 precise measurements (excellent energy resolution) has forced us to introduce a new parametrization (Cabibbo, Cabibbo-Isidori, ..), which takes into account the cusp effect ($K^+ \to \pi^+\pi^+\pi^- \to \pi^+\pi^0\pi^0$)

$$M_0 + M_1$$

$$M_0 = 1 + g_0 \cdot \frac{(s_3 - s_0)}{2m_{\pi^+}^2} + \frac{h'^2}{2m_{\pi^+}^4}$$

M_1 accounts for the non-analytic piece due to $\pi\pi$ rescattering ampl., a_0 and a_2;

$$g_0 \sim g^{PDG}, \qquad h' \sim h^{PDG} - (\frac{g}{2})^2$$

CP asymmetry

- slope asymm.

$$\frac{\Delta g}{2g} = \frac{g_+ - g_-}{g_+ + g_-} \quad \overset{\mathrm{SM}}{<} 10^{-5} \quad \overset{\mathrm{PDG04}}{<} 7 \cdot 10^{-3} \quad \overset{\mathrm{NP}}{<} 10^{-4}$$

- New CP asymmetry in $K^+ \to \pi^+\pi^0\pi^0$ TNF,

$$\Delta g/2g = (2 \pm 20) \cdot 10^{-4}$$

- $K^+ \to \pi^+\pi^+\pi^-$ NA48

$$\Delta g/2g = (1.7 \pm 2.8) \cdot 10^{-4}$$

K^+ section: rare decays, highlights

- $K^+ \to \pi^+ \nu\bar{\nu}$, final analysis by BNL (B949) , 3 evts.

  $BR(K^+ \to \pi^+ \nu\bar{\nu})$ very much in agreement with SM

- BNL (B949) also
  - $K^+ \to \pi^+ \gamma\gamma$, improved analysis of the diphoton invariant mass spectrum (in the low mass region)
  - $K^+ \to \pi^+ \gamma$ new bound

K^0 section

- K^0 mean square radius measured (KTeV)
- CPT: The new determination of of the CP asymmetry

$$A_S = \frac{\Gamma(K_S \to \pi^- e^+ \nu) - \Gamma(K_S \to \pi^+ e^- \nu)}{\Gamma(K_S \to \pi^- e^+ \nu) + \Gamma(K_S \to \pi^+ e^- \nu)}$$

by KLOE has allowed the determination of various CPT related quantities

$\mathrm{Re}(y)$ (a non-zero value would violate CPT in $\Delta S = \Delta Q$ amplitudes)

$\mathrm{Re}(x_-)$ (a non-zero value would violate CPT in $\Delta S \neq \Delta Q$ amplitudes)

$\mathrm{Re}(x_+)$ (a non-zero value would violate $\Delta S = \Delta Q$ in CPT conserving amplitudes)

K_S section

- KLOE (EPJ C) has measured

$$\frac{B(K_S \to \pi^+\pi^-)}{B(K_S \to \pi^0\pi^0)} = 2.2549 \pm 0.0054$$

- $\leq$ KLOE 2.11 ± 0.09: affects the the whole K_S section

- NA48, through time interference, $B(K_S \to \pi^+\pi^-\pi^0)$ measured (and phases)

- $B(K_S \to \pi e \nu)$ measured (and linear form factor) from KLOE

- Semileptonic CP asymm. A_S measured (KLOE): crucial for CPT tests

K_S section. Rare decays: highlights

- $BR(K_S \to \pi^+\pi^-\pi^0)$: NA48 $BR = (4.7 \pm 2.8) \cdot 10^{-7}$
- $BR(K_S \to 3\pi^0)$:
  - NA48 (7 M),
  - KLOE (37.8 M).
    $BR < 1.2 \cdot 10^{-7}$ at 90% C.L.

K_L section

- K_L lifetime measured by KLOE in **two** different ways

  i) Direct K_L tagged by $K_S \to \pi^+\pi^-$

  ii) Indirect The four major K_L BR's ($K_{\ell 3}$, $K_L \to 3\pi$) are measured and the remainder is taken from PDG04: Imposing the sum must be equal to 1, KLOE gets an independent K_L lifetime measurement.

  We have taken into account all correlations (matrix involving the different decay channels) to include this independent measurement

Big change in the K_L BR's

- KTEV

$$\frac{BR(K_L \to \pi^+\pi^-\pi^0)}{BR(K_L \to \pi^\pm e^\pm \nu)} = 0.3078 \pm 0.0005 \pm 0.0017$$

previously measured by NA31 (Kreutz et al 95) $0.336 \pm 0.003 \pm 0.007$. It has created many problems for all K_L BR's: Kreutz not used anymore.

- Analogously for $\dfrac{BR(K_L \to 3\pi^0)}{BR(K_L \to \pi^\pm e^\mp \nu)}$,

$\dfrac{BR(K_L \to \pi^\pm \mu^\mp \nu)}{BR(K_L \to \pi^\pm e^\mp \nu)}$ and $BR(K_L \to \pi^\pm \mu^\mp \nu)$ were improved drastically by KTEV and KLOE

- Also KTEV and KLOE improved $BR(K_L \to \pi^+\pi^-)$ and as result the value of ϵ is substantially changed (decreased by 3σ's)

- These have changed all K_L BR's

- These dramatic improvements in precision have allowed us to remove a lot of lower statistics expts. from the fits.

K_L Section

- Form factor for semileptonic decays (KTEV and KLOE): we have added all the new parametrizations linear, quadratic and pole.
- $BR(K_L \to \pi^0 e^+ e^-) < 2.8 \cdot 10^{-10}$ at 90% C.L. KTEV

Wishful thinkings

- Find a nice place for $\pi\pi$ scattering lengths